(2)

P^2NBC^2 Heat Strain Decision Aid

USER'S GUIDE

Version 2.1

Contract No. DAAL02-90-C-0071

April 1993

Science Applications International Corporation
An Employee-Owned Company

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This report describes the capabilities and proper use of the P^2NBC^2 Heat Strain Decision Aid Software System. The P^2NBC^2 HSDA is a stand alone analytical tool for evaluating the effects of heat stress on soldier performance limits. User inputs include clothing type/chemical protective posture, activity level based on military task type, soldier anthropometric characteristics and acclimatization status, and environmental conditions (air temperature, wind speed, humidity, and solar radiation). The P^2NBC^2 HSDA provides color graphics, tabular, and data file outputs for heat casualty risk, sustainable work/rest cycle limits, maximum safe work time, and associated drinking water requirements.

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p^2NBC^2 Heat Strain Soldier Performance Heat Injury Risk

Unclassified Unclassified Unclassified UL

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- MAJ Matthew J. Reardon, USARIEM, for giving us access to the model he has been developing at USARIEM. His help greatly reduced the effort required to build a viable user interface.

Funding for the development of the Heat Strain Decision Aid (HSDA) was provided by the U.S. Army P^2NBC^2 Program Office.

ADVISORY

The P²NBC² Heat Strain Decision Aid is a developmental analytical tool that has not yet been determined safe or suitable for use in making decisions that could affect the health and safety of personnel. At this writing, the program and the algorithms embedded within it are at the evaluation/validation stage.

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The user should understand that casualty predictions are based on a limited data set and should be interpreted with that in mind.

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1.0 INTRODUCTION

The P²NBC² Heat Strain Decision Aid (HSDA) is a menu-driven tool designed to help predict and enhance soldier performance and endurance. It is equipped with a set of default and preset input selections as well as options for entering user-determined values. The results can be viewed in numeric or graphic displays, depending on the type of assessment conducted. Outputs can be saved and exported to other applications.

1.1 Background

Over the past 20 years, the U.S. Army Research Institute for Environmental Medicine (USARIEM) has compiled a database of test results and developed a set of predictive equations for the core temperature, heart rate, and water requirements for soldiers performing physical work in various clothing configurations under a range of environmental conditions. From this, USARIEM developed a Hewlett-Packard 41-CV hand-held calculator model that predicts the amount of heat strain soldiers will experience under a given set of conditions and determines appropriate work-rest and water intake regimens.

The HSDA is designed to replace the hand-held calculator version of the USARIEM model. The algorithms used in that model have been translated into Ada, a high-level programming language, for use on personal computers. In addition, several modifications of the USARIEM model have been incorporated into the HSDA. It is now possible to specify soldier height and weight, dehydration state, and heat acclimatization; calculate core temperature and determine water requirements; and predict equilibrium core temperature for work and rest periods as well as the probability of heat casualties. Finally, a user interface has been added to make using the application as easy as possible. Menu selections are provided for everything from inputting data to graphing the results.

1.2 Purpose of the P²NBC² Heat Strain Decision Aid

The HSDA is designed to use environmental and soldier-related data to determine water requirements, establish optimal work-rest cycles, and estimate the effects of work performed with and without heat strain countermeasures. The user interface was developed to accommodate the capabilities and the requirements of the full range of personnel and organizations concerned with soldier performance and endurance. Researchers and military testers should find HSDA an excellent tool for designing laboratory and field tests. They will not only be able to better establish conditions that are likely to induce heat strain but also ensure that unintended heat strain does not occur. This could increase the safety margin during testing and decrease the effects of confounding variables, making the resulting findings easier to

interpret. Materiel developers, required to evaluate products throughout the various phases of the acquisition cycle under climatic extremes with various clothing configurations, should be able to gain comparable benefits. In addition, they could make headway by using the predictive capabilities of the model even before testing is possible. Specifications could be more precisely written and relevant soldier factors incorporated as early as the drawing-board stage. Military analysts, planners, and decision-makers could use HSDA predictions and recommendations in combination with outputs from other models to gain a more comprehensive understanding of areas of interest. And intelligence and operations officers could use the HSDA in the field to gain a better estimate of both enemy and friendly capabilities. For example, interactions between weather, terrain, and chemical-protective ensemble requirements -- all of which have heat-strain potential -- could be used to better anticipate and plan avenues of approach and time of attack.

1.3 Capabilities

The HSDA is entirely menu-driven. The basic structure is shown in Figure 1. HSDA accepts inputs for all parameters through pop-up windows, where you can either select from an array of predetermined values or type in your own numbers. The application checks every entry to ensure it is within a valid range. If you enter a value the model cannot accommodate, an error message appears and displays the proper range. The application also converts units through pop-up windows. Obtaining results can be as simple as selecting the **Calculate** command. HSDA automatically displays the results if you have only entered one value for each of the input variables. If you have used more than one value for a particular variable, the results are available through the **Graph** command. You can generate any of a number of graphs by selecting functions from various menus. The HSDA does not print results or graphs; however, it does allow you to save the results to an ASCII file for printing through DOS or for exporting to other applications. Graphics screens can also be regenerated exactly as they appear on your computer using any screen-capture program, then printed through standard graphics and word processing applications (e.g., Harvard Graphics[1], Paragraph 3.9).

1.3.1 Inputs. HSDA uses *[Ambient] Temperature*, *Humidity*, *Wind Speed*, *Solar Load*, *Dehydration*, *Work Activity*, *Acclimatization*, *Soldier Attributes*, *Clothing Type*, and *Accepted Casualty Risk* as inputs. Detailed descriptions of the input parameters, default values, and acceptable ranges are provided in Section 3.3 of this manual. If you are unfamiliar with prediction models like HSDA, using the default values will give you an opportunity to examine the capabilities of the application without having to come up with realistic data. Guidance is also provided for knowledgeable users who understand the outputs but may not have the detailed scientific knowledge to supply inputs in the units of measure HSDA uses to perform its calculations. Variations in metabolic rate resulting from different levels of work activity, for example, are critical inputs for HSDA. If you think of this in watts, as HSDA does,

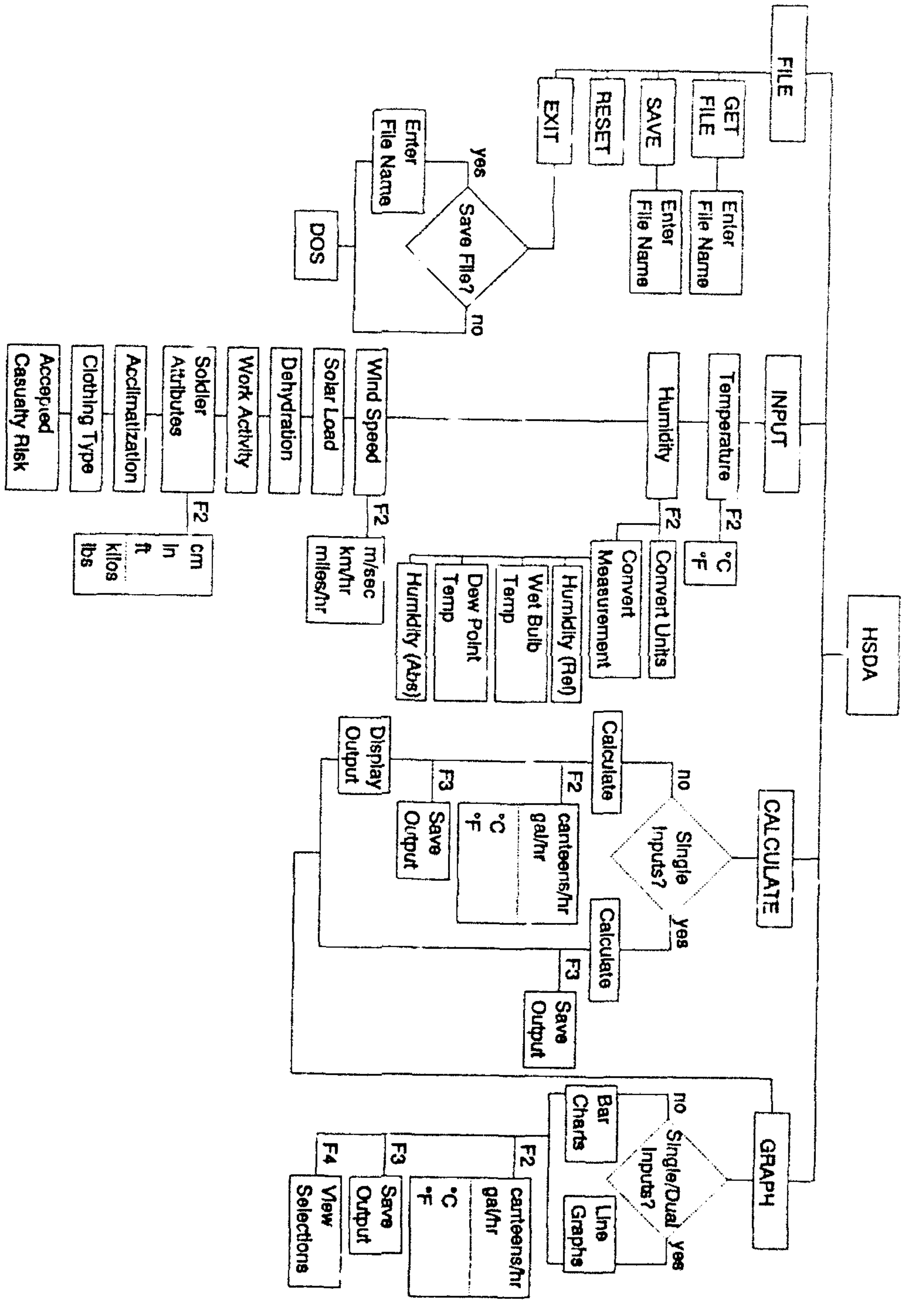

Figure 1. HSDA components and interrelationships.

you can enter these values directly; if you do not, you can select a close approximation (in watts) by browsing through a list of 32 easily-understood tasks such as *"Driving a Truck"*.

While HSDA needs one value for each of the above-mentioned variables, it can accommodate more than one value per variable ... within constraints. No more than eight values can be used for a given variable (see Section 3.3), and multiple values can only be entered for one variable at a time. This has its advantages: you will be encouraged to select your inputs thoughtfully and required to follow good scientific practice, i.e., systematically examining one parameter while holding all others constant. You may save your inputs to a file upon exiting HSDA. This allows you to recall specific inputs whenever you choose. Whether or not you save to a file, HSDA remembers the most recent inputs for the next time you use the program.

1.3.2 Outputs.

The type of output you get depends, in part, on whether you enter one, two, or more inputs for a variable. When you finish entering all the inputs and select the **Calculate** command, HSDA displays single-input results in two columns at the bottom of the main screen. One column (*Recommended Discipline*) shows parameters of a regimen designed to optimize performance within the acceptable casualty limits you have specified. Work-rest ratios for *Work Cycle* (minutes) and *Water Required* (canteens/hour) are presented along with *Maximum Work Time* (minutes) for continuous effort. The other column shows predictions for *Equilibrium [Core] Temperature* (°C) and the *Probability of Casualty* (%) for the same inputs if the effort is undertaken *Without Discipline*. If you select the **Graph** command, you can compare the effects of *No Thermal Discipline*, *Work/Rest Discipline*, and a *Custom Thermal Discipline* you design yourself through line graphs of core temperature changes over time. Such comparisons are also possible if you have entered two inputs for a given variable.

If you have used more than two inputs for a given variable, you can view bar charts that show how the variations you have specified for a particular parameter affect *Work Time*, *Recovery Time*, *Work Water Requirements*, *Recovery Water Requirements*, and *Maximum Work Time* (Recommended Discipline) as well as *Work Equilibrium Core Temperature*, *Rest Equilibrium Core Temperature*, and *Probability of Casualty* (Without Discipline).

1.4 Hardware Requirements

The HSDA application requires, as a minimum, the following hardware and operating system components:

- o An IBM[2] personal computer (PC) or an IBM[2]-compatible computer
- o A monochrome monitor
- o A 5.25" and/or 3.5" high-density, floppy-disk drive
- o DOS, Version 3.0 or higher
- o 470 kilobytes (K) available random access memory (RAM)

Although the following hardware is not required to run HSDA, it will greatly improve performance of the application:

- o A hard drive with at least 1 megabyte (M) available storage space
- o A color video-graphics-array (VGA) monitor
- o A math coprocessor

You should be aware that even if your computer has 640K RAM, the entire space may not actually be available. This happens mainly with memory-resident programs, such as Sidekick[3], and drivers, such as mouse drivers and CD-ROM drivers. Also, some graphics packages occupy a portion of RAM even after they are exited. Memory-resident programs may need to be removed from the autoexec.bat or config.sys files (see Section 2.0). A math coprocessor -- though not strictly required for operation of HSDA -- is strongly recommended. Without a math coprocessor, calculations and graphics display can be extremely slow, especially with multiple inputs.

1.5 Assistance and Problem Reporting

If you encounter any problems and need assistance, please write or call. We also welcome comments and suggestions for HSDA improvement. You can contact us at:

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626 Towne Center Drive, Suite 205
Joppa, Maryland 21085

ATTN: Richard McNally or Jack Berndt

Phone: (410) 679-9800
FAX: (410) 679-3705

1.6 Conventions Used in This Manual

1.6.1 Organization. The body of this manual is divided into four sections. The first section describes the background, usage, requirements, and capabilities of the HSDA. The second section is intended for installation and first-time use of the application. It contains the installation procedures and generally familiarizes you with HSDA. First-time users of HSDA should not skip Section 2. Section 3 contains detailed information, explaining how the program works, describing each input variable and discussing the output. Finally, a brief bibliography is provided for those who would like to gain a better understanding of heat-strain issues and terminology. An appendix is also provided with a glossary of terms, a list of error messages, and a user survey. The Appendix as a whole should help you better understand both the manual and the application; the error messages should help you in troubleshooting problems; and the survey should help us better meet your needs.

1.6.2 Key Words. For the purposes of this manual, input variables, the various options available for these variables, and outputs (values and graphs) are considered to be key words. Key words appear in *italics* for easy identification. For example, the key word *Temperature* always appears in italics when it refers to an input variable. Because *Temperature* is used in a number of ways in the application and also refers to two very different types of temperature -- ambient (environmental) and core (individual internal), these modifiers are added in brackets (e.g., *[Ambient] Temperature* when HSDA displays them in truncated form due to space constraints.

1.6.3 Commands. Commands are the options shown in the menu bar across the top of the screen. The commands and their menu options appear in **bold face**. An example of a command is **Calculate**, which appears in bold whenever it is referred to as a command.

1.6.4 Special Keys. Special keys are any keys that do not type letters or numbers. These keys appear boldfaced and in **<brackets>**. Examples of special keys are the escape key **<Esc>** and the Function-3 key **<F3>**.

1.6.5 Typed Entries. Anytime you are asked to type in a value or a command, as happens during installation, the exact characters you should type appear in **"quotes"** and bold face. Do not type in the quotation marks themselves. Examples of typed responses are the **"copy"** and **"mkdir"** commands used by DOS for installation of HSDA. Be sure to type in any spaces that appear between words within the quotation marks.

2.0 GETTING STARTED

2.1 Installation

You received either a 5.25" or a 3.5" floppy diskette labeled "Heat Strain Decision Aid Version 2.0" along with this manual as part of your HSDA package. These are the diskettes containing the program, the default inputs, and other essential files (See Appendix B).

2.1.1 Checking the Available RAM. HSDA will not run if your computer does not have sufficient RAM (470K). You can check to see how much RAM is available by typing "**mem**" followed by **<Enter>**. The screen fills up with all sorts of information, but the line you are interested in is "largest executable program size". The number to the left should be at least 470000. If it is less, you need to remove programs or drivers from RAM. This manual cannot cover all the possibilities for what is using the RAM and, therefore, contains no instructions for correcting the problem. Please consult your DOS manual for instructions on reducing RAM usage.

2.1.2 Preparing to Run HSDA from a Floppy Disk. HSDA runs slower from a floppy disk than from a hard drive. Because HSDA takes up 400K of storage space, there is not enough room left on the diskette for you to save input and output files. Before you run HSDA, we recommend that you copy the original diskette and use HSDA on the copied diskette. This will prevent you from losing the program should anything destroy or corrupt the original diskette. Perform the following steps to copy the diskette:

a. Place the HSDA diskette in the appropriate drive. Since the diskette is high-density, you will need to place it in a high-density drive. Also, you must know what the drive is called. For clarity, these instructions refer to drive A. Your diskette may need to be placed in drive B. If this is the case, simply substitute "**b:**" for "**a:**" in these instructions.

b. If you only have one disk drive that can read the HSDA diskette, place HSDA into the appropriate drive and type the following command: "**diskcopy a: a:**" and press **<Enter>**. **NOTE:** Using the diskcopy command deletes everything on the destination diskette! You should hear the drive working, then the screen prompts for the destination diskette (your copy diskette). When this happens, remove the HSDA diskette from drive A. Place a formatted, high-density diskette into drive A, and press **<Enter>**. When prompted, remove the copy diskette and replace HSDA. Continue until the screen indicates that the copy is complete.

c. If you have two drives that can read the HSDA diskette or if you want to copy HSDA onto another drive format other than the one that reads the HSDA diskette, perform the following steps. Note that the copy diskette

must be high density, since HSDA requires 400K of storage space. Place the HSDA diskette into the appropriate drive (called drive A here). Place the formatted, high-density copy diskette into another appropriate drive (here referred to as drive B). Type "**copy a:*.* b:**" and press **<Enter>**. This copies all of the files from drive A to drive B. No files will be deleted from the copy diskette. If the copy diskette is not blank, you may run out of storage space. Either use another (blank) diskette and perform this step over or delete the contents of the copy diskette first and perform step c again.

d. Place the original HSDA diskette in a storage container. Run the program from the copy diskette (see Section 2.2).

2.1.3 Preparing to Run HSDA from the Hard Drive. Installing HSDA onto the hard drive will maximize performance. Using the hard drive rather than a floppy disk increases the speed of operation and allows you to save a number of files. Perform the following steps to install HSDA onto your hard drive:

a. Turn your computer on. If it is already on, type "**cd **" and press **<Enter>** to ensure you are in the root directory. If you are in the root directory, the screen should display "**C:>**". If a letter other than "**C**" appears, either one of the floppy drives is current or you are using a drive other than C. If the screen indicates you are in drive A or B, type "**c:**" and press **<Enter>**.

b. Type "**mkdir hsda**" and press **<Enter>** to create a directory for the HSDA on your hard drive.

c. Place the HSDA diskette in the appropriate drive. Type the drive designation followed by a colon (for example "**a:**") and press **<Enter>** to change to the drive containing the installation diskette.

d. Type "**copy *.* c:\hsda**" to copy all the files from the installation diskette into the directory HSDA that you created in step b. NOTE: You must install all files in the HSDA directory.

2.2 Starting the Application

The procedure for starting HSDA differs slightly depending on whether you operate from a floppy diskette or a hard drive. If you are running HSDA from a floppy, switch to the appropriate drive by typing "**a:**", "**b:**", or other letter designating where the HSDA diskette is located. If you are running HSDA from the hard drive, perform the first step in Paragraph 2.1.3 above. Then type "**cd hsda**" to change to the directory where you installed HSDA. To start the application from

either the floppy or the hard drive, type "**hsda**". As the application loads, it briefly shows a program-identification screen before displaying the advisory, which is also printed on the first page of this guide. To continue, press **<Enter>**.

The next screen displayed contains the Main Menu. Commands are printed along the top of the screen, called the menu bar. Input parameters are located immediately below the menu bar, and outputs occupy the bottom of the screen. Note how the first command, **File**, appears in reverse video. This is called highlighting, and it serves as a cursor for the menus and windows. Pressing **<Enter>** while a command is highlighted either executes the command (such as **Calculate**) or brings up a menu of options. Pressing the arrow keys (<↑>, <↓>, <→>, <←>) moves the cursor along the menus in the direction indicated. Refer to Paragraph 3.1 for more detailed instructions on how to use the menus. Sections 3.2, 3.3, and 3.4 explain in detail how each section of the application works.

2.3 Saving and Exiting the Application

To exit HSDA, move the cursor to the **File** command. If your cursor is in a data field, press **<Esc>** to return to the menu bar. Press the **<←>** or **<→>** keys to move along the menu bar, or press the letter "**f**". A window with the following options appears: **Get File, Save File, Directory, Reset,** and **Exit.** Cursor down (using the arrow keys) to **Exit**, and press **<Enter>**, or as an alternative, simply press "**e**" or "**x**". If you selected **Input** from the menu bar during the session, another window appears asking if you want to save the inputs. Press "**y**" if you want to save the inputs as a file, in which case your input values will be available under the specified file name any time you use HSDA. Press "**n**" if you do not want to save your inputs to a file. Regardless, the application automatically remembers your inputs for the next time you use HSDA, then exits and returns you to the DOS prompt. The current directory is still HSDA.

3.0 USING THE APPLICATION

3.1 Conventions

Several conventions were adopted for HSDA operation. They provide you with a consistent format for using the application. Although different portions of HSDA (the menu bar, data input, etc.) perform their functions in different ways, they share certain characteristics. No matter where you are in the application, if you know the conventions you will be able to navigate through your current area of interest or move to another area. The following paragraphs explain the conventions used by HSDA and how they are used in different areas of the application.

3.1.1 Pull-Down Menus. When HSDA finishes loading and you have pressed any key to continue past the advisory, the main screen is displayed. Commands are printed along the top of the screen, called the menu bar. This is the Main Menu. The **File** and **Graph** commands are pull-down menus. This means that when you press **<Enter>** while the cursor rests on **File** or **Graph**, more options appear in a box below the command. You may then use the arrow keys to scroll through the list of options. When the option you want to perform is highlighted, press **<Enter>** and HSDA performs the function indicated. If you want to exit the pull-down menu without selecting an option, press **<Esc>**. Section 3.2 describes each command on the menu bar in more detail.

3.1.2 Pop-Up Windows. Pop-up windows are boxes that appear when you need to know something important about the application. For example, when you input numerical data that is outside of the valid range, a box appears and displays the maximum and minimum values allowed for the parameter. This type of pop-up window does not disappear on its own. You must press **<Esc>** to make it disappear. Other pop-up windows disappear on their own after displaying for a short period of time. You will know that you need to press **<Esc>** when the pop-up window remains longer than several seconds.

3.1.3 Pick Lists. The input section of the HSDA frequently uses pick lists to make data entry easier. Pick lists are boxes containing a number of predefined values for certain input parameters. Pressing **<Enter>** while the cursor is on one of these fields causes a box full of options to appear. Use the arrow keys to scroll through the list. When the cursor reaches the desired option, press **<Enter>** to select it. Another pick list then appears with two options: "Add to Current List" and "Replace Current List". Select the first option to create multiple inputs for that variable. Select the latter option to change the single input to the value you have just chosen. Both pick lists then disappear, and you can move to the next data field. Several input parameters have more preset values than there is space. Press **<↓>** when the cursor reaches the bottom option to see if the text scrolls upward. When the text stops scrolling, you have reached the last option. Pressing **<Esc>** from a pick list before you change any values or make selections returns the cursor to the input screen

without changing the parameter. NOTE: Selecting *User Defined* from any pick list causes other pick lists to appear. These are explained in more detail in Section 3.3.

3.1.4 Scalar Fields. Scalar fields are input data fields that allow you to enter a string of numbers or specify a range. *[Ambient] Temperature*, *Humidity*, *Wind Speed*, and *Acclimatization* are variables that have scalar fields. You may enter up to eight numbers with a total entry length of 26 characters. The 27th character typed will simply overwrite character 26. Numerals, "+", ".", and "-" characters are all acceptable parts of the input. Commas (",") delineate entries, and three periods ("...") specify a range. A discrete list is simply a series of numbers separated by commas: "1.1,2.1,3.4". A range consists of two numbers separated by a comma to denote the lower limit and the increment, three dots, and a number denoting the upper limit: "20,22...29". This results in HSDA reading the following numbers: "20, 22, 24, 26, and 28". Note that HSDA accepted 28 rather than the specified 29 as the upper limit. HSDA chooses the closest number within the specified increment if the upper limit does not fit the pattern.

3.1.5 Maneuvering Through Data Fields. Once your cursor is in the data-entry section of the main screen (select **Input** from the menu bar), move the cursor through the fields by pressing the arrow keys (< ↑ >, < ↓ >, <→>, <←>). To enter data into a numeric field, simply type the number in decimal format. For multiple inputs, separate the entries by commas. To select a predetermined value, press **<Enter>** and the pick-list appears (see Paragraph 3.1.3). When multiple inputs have been entered in a predetermined-value field, *Multiple Inputs* appears in the field. When the cursor rests on an input parameter containing multiple inputs, a pop-up window displays the selected values on the screen. In these fields, the <→> and <←> scroll through the pop-up window rather than advancing the cursor to the next or previous field. Use < ↑ > and < ↓ > to move to the next or previous field. *User Defined* entries perform in the same manner as *Multiple Inputs*.

3.1.6 User-Defined Selections. Although HSDA offers many preset selections, there are times when you may want to enter your own values instead. If this is the case, select *User Defined* from the pick list. Each input parameter has a different set of user-defined fields. When you first select *User Defined*, the parameters contain values for the currently selected predefined option. HSDA requires data for each input field to perform the necessary calculations, so you do not have the option of defining a field as null. You will notice that there are always values (e.g., default settings, zeros) present even when you choose to disregard a particular field. Check these fields. They could contain data from a previous session that you do not wish to carry forward. Once you have entered the data you want, press **<Esc>** to return to the input section of the screen.

3.2 Main Menu Commands

The Main Menu commands appear in the menu bar across the top of the main screen, as shown in Figure 2. These commands allow you to save and load input files, input data, calculate and graph the results, and save the results to an ASCII file. The following paragraphs explain each command with its options and the functions performed.

```
FILE ======= INPUT ======= CALCULATE ==== GRAPH ========================

  INPUT VARIABLES
Temperature         (oC)                              35.0
Humidity             (%)                              50.0
Wind Speed       (m/sec)                               0.5
Solar Load                                      * Full Sun
Dehydration          (%)                 User Defined 1.24%
Work Activity                   * Walking Hard Surface, 2
                               .0m/s No Load  [525 watts]
Acclimatization   (days)                               0.0
Soldier Attributes                     * Ht. 172 Wt. 70
Clothing Type                   * Battledress Overgarment
                                       (BDO) [closed]
Accepted Casualty Risk                          * Light

RECOMMENDED DISCIPLINE                 WITHOUT DISCIPLINE
                          Work:Rest                                 Work:Rest
Work Cycle          (min)              Equilibrium Temp.  (oC)
Water Required    (cm/hr)              Prob. of Casualty   (%)
Maximum Work Time (min)
```

Figure 2. Main menu and main screen.

3.2.1 File. As shown in Figure 3, the **File** command performs five different operations: **Get File, Save File, Directory, Reset,** and **Exit**. You can select each as described above or by pressing the initial letter of the command word (for example **"g"** for **Get File**). To cancel the **Get File, Save File, Directory,** and **Exit** commands, press **<Esc>** during the prompts before any action is performed.

a. **Get File** retrieves previously saved input files from disk (the HSDA directory). After you select **Get File** from the **File** pull-down menu, you are prompted to: "Enter name for new file". Type the name of the file and

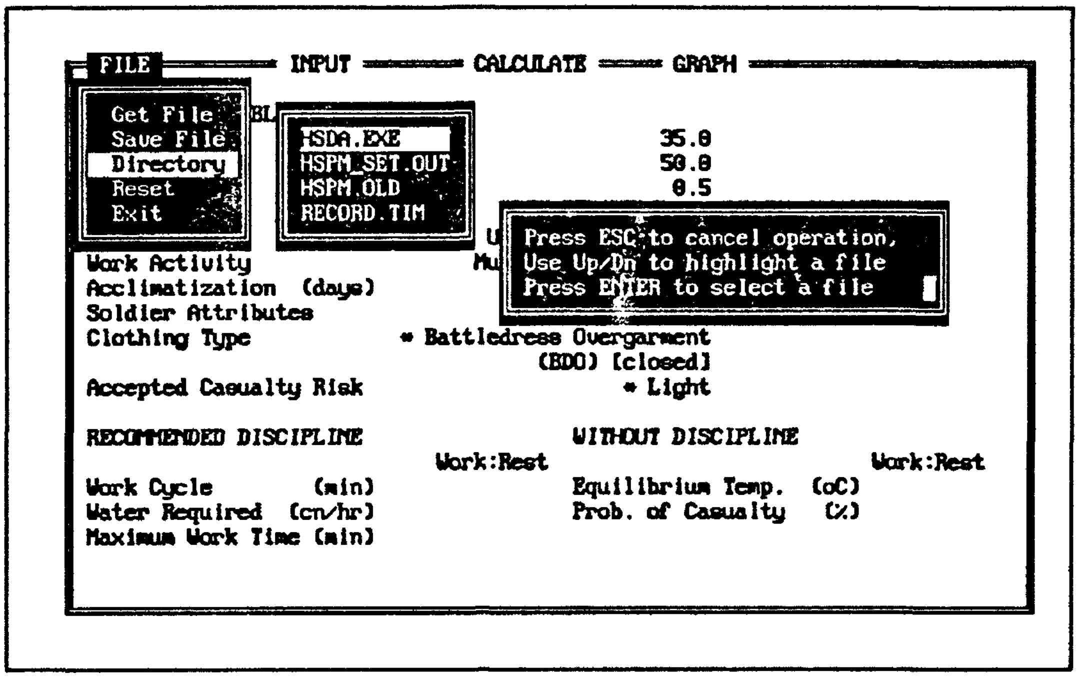

Figure 3. File menu with directory option selected.

press **<Enter>**. The file must be in HSDA-readable binary format, which means it must have been saved through HSDA using **Save File** or **Exit**. The input area of the screen fills with the values from the file you just selected. If you type in an inappropriate or non-existent file name, an error message appears (see Appendix B) and you may try again. Use the **Directory** command to look at the input files saved in the HSDA directory.

b. **Save File** saves the current (most recently entered) input values in an input file with binary format, which can be retrieved using the **Get File** and **Directory** commands. When you select **Save File** from the **File** window, the screen prompts, "Enter name for data file". Type the name you wish to call the file, and press **<Enter>**.

c. **Directory** displays a pick list of files in the HSDA directory. You may select a file from this list by using the arrow keys to highlight the file name and pressing **<Enter>**. Only binary files saved through HSDA can be selected from the pick list. This pick list scrolls when there are more files than there is space in the window that appears on the screen. Note that the

pick list shows any files that you might have placed in the HSDA directory, including ones that cannot be used here (see Figure 3): the one containing the HSDA program itself (HSDA.EXE), screen-capture files (SCREEN00.PCX), and an HSDA-generated text file (BASELINE.TXT) of the sort described below in Sections 3.2.3 and 3.2.4.

d. **Reset** loads default values that were current when you installed HSDA. This is helpful if used as a baseline for your inputs. It can also help if you get into trouble inputting data.

f. **Exit** terminates the session. A window asks, "Exit without saving? [Y/N]". If you press "n", the screen asks for a file name, just as **Save File** does. Respond in the same manner. Your inputs will also become the defaults for the next session. If you press "y", HSDA immediately terminates and the most recently-entered inputs will automatically appear in the input data fields when you start your next session.

3.2.2 Input. Selecting **Input** moves your cursor to the first parameter displayed on the main screen. Input parameter names and the associated data-entry fields occupy the upper portion of the screen. There are three types of input fields: scalar, predefined, and user-defined. Scalar fields are numeric, i.e., you can only enter numbers, which you can add to or replace as desired. Refer to Paragraph 3.1.4 for a complete discussion of scalar fields. Predefined values are displayed in pick lists such as the one shown in Figure 4 for *Work Activity*. NOTE: These lists can be extensive, requiring scrolling. Select an option and press **<Esc>**. For multiple inputs (Figure 4), select "Add to current list" when prompted. When you enter more than one predefined value, "Multiple Inputs" appears in the data entry field. User-defined fields are available through the pick lists of predefined fields. When you select *User Defined*, another window appears that contains relevant variables. Refer to Paragraph 3.1.6 for more information on user-defined fields. Use the arrow keys to move through the various input fields. To exit **Input**, press **<Esc>**.

3.2.3 Calculate. The **Calculate** command does just what its name suggests: it generates results from the input values. When HSDA is performing the calculations, "Working ..." appears in a pop-up window. Calculation speed varies among different computers. It will be very slow on a machine without a math coprocessor; with a math coprocessor, it should take from seconds to a few minutes to complete. If calculation time exceeds your normal expectations, wait a while before concluding something has gone wrong. If more than a minute or so of calculation time is required, HSDA will display a message with estimated time to complete.

Once the calculations are completed, single-input results are displayed along the bottom of the screen as shown in Figure 5. This figure also shows another HSDA capability: units of measure can be changed by pressing <F2> and the values will be automatically recalculated. This feature is available in **Input** and **Graph** as well.

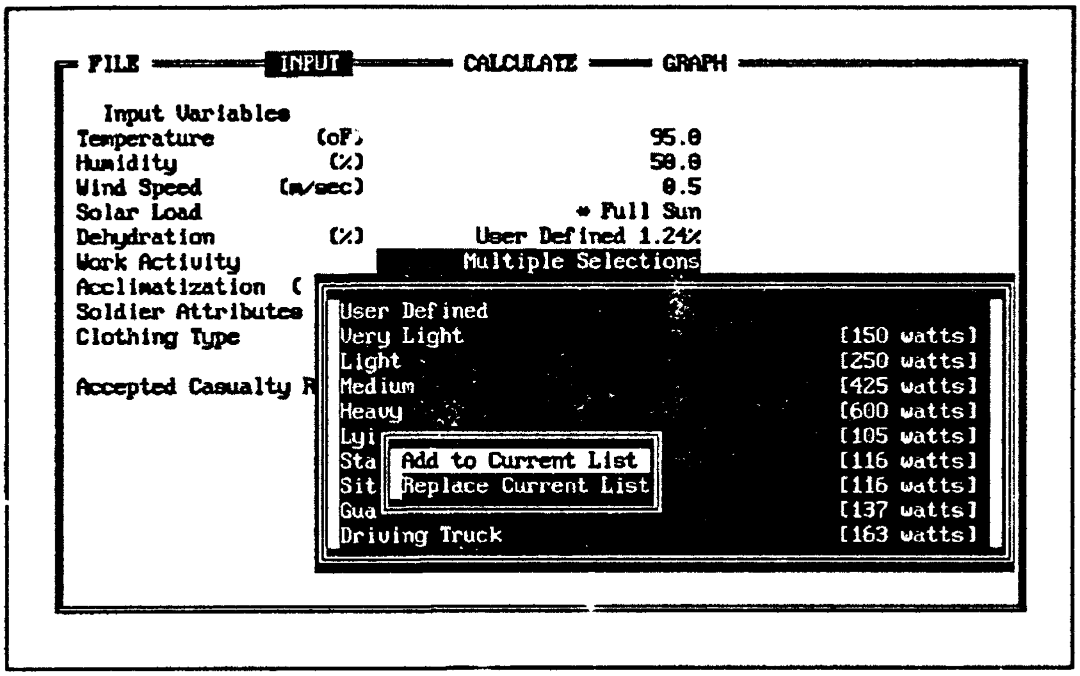

Figure 4. Multiple inputs with pick list.

However, converting in one place does not result in universal conversion. The units displayed -- unless you intervene -- are the units HSDA uses internally. In the example in Figure 5, you will note that *[Ambient] Temperature* -- as an input variable -- has been converted to degrees Fahrenheit but *Equilibrium [Core] Temperature* -- as an output -- still needs to be converted to Fahrenheit using the pop-up window, if that is how you want to view it. Results from multiple inputs are not displayed on the main screen, but they are available through the **Graph** command. You may save the inputs and outputs to a text file (ASCII format) by pressing **<F3>** before you execute another command. When multiple inputs have been entered, the text file prints the entire list of inputs and outputs for each value in the multiple list. See Section 3.8 for more information on saving to text files.

3.2.4 Graph. The **Graph** command displays the results in either line graph or bar chart format. If you did not previously execute **Calculate, Graph** will also run the calculations for output. Line graphs are generated when you enter one- or two-input sets. Multiple-input (three to eight) set results are presented as bar charts. An asterisk (*) appears on the graph when the value goes out of range for the chart axes, and the actual value is superimposed on the appropriate bar. To select the functions you want graphed for single-input sets, make a selection from the pop-up window that appears by pressing **<Enter>**. A ">" appears beside the function name. You may

select more than one function for each graph. When you have made your selections, cursor down to *Run Selections* and press <Enter>. The graph then displays. Press any key except <Esc> to return to the Main Menu. For multiple-input sets, select from a pick list of functions. For both line graphs and bar charts, input values appear to the left of the graphic display. If the graph is based on multiple inputs, the values for that parameter will not be among those listed but can be displayed by pressing <F4>. <F4> also provides values and functions when more than one curve is displayed on a line graph.

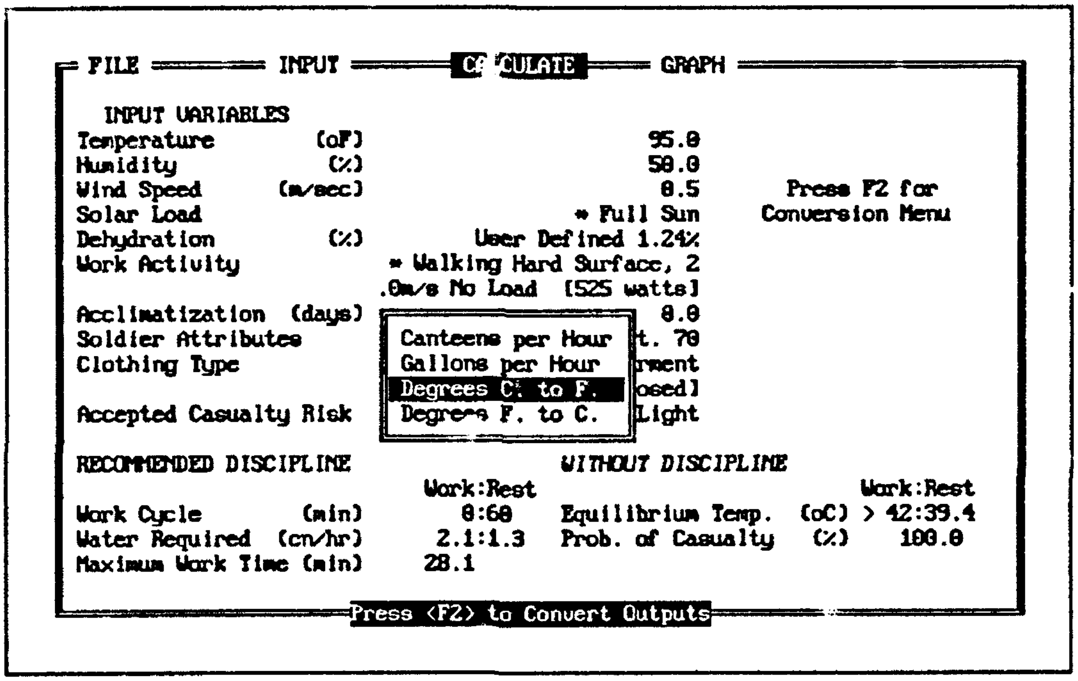

Figure 5. Calculate with unit-of-measure conversion.

Graph provides an option for saving results to a text file (ASCII format). While the chosen graph is displayed, press <F3>, and the screen prompts for the name of the text file. Type a name and press <Enter>. Examples of how different types of graphs are specified, how they look when displayed, and the type of text file in which graph data are saved are shown in Section 3.4, along with a more detailed discussion of all HSDA outputs.

3.3 Input Variables

HSDA predictions and recommendations require inputs for ten parameters. Their attributes and how HSDA handles them are described below and summarized in Table 1. The main HSDA screen used for inputting data is the same one previously presented in Figures 2-5. Default values, which you may want to use as a starting point, are identified on the screen by asterisks. They are also listed in Table 1, along with the valid range for each variable.

3.3.1 Temperature. *Temperature* --here-- refers to the ambient temperature (dry-bulb temperature) of the air. The default setting is 35°C, and the valid range is 10.-0°C to 65.0°C. You may convert from centigrade (C) to Fahrenheit (F) by pressing <F2>. A pick list of conversions appears. Choose the desired conversion, and the variable display changes to the desired units. Although the value appears on the screen in °F, HSDA uses °C for its calculations.

[Ambient] Temperature is a scalar variable. See Paragraph 3.1.4 for instruction on how to enter multiple inputs in scalar fields. You may enter up to eight values in this field. Entering more than one value causes HSDA to treat the data set as dual or multiple inputs, and the **Graph** and **Calculate** functions behave accordingly.

3.3.2 Humidity. *Humidity* is the measurable amount of moisture in the atmosphere. The default setting is 10.0%, and the valid range is 0 to 100%. It is a scalar variable. If you press <F2> (the same key you use to make unit-of-measurement conversions), you are presented with a number of ways for measuring humidity. The following selections change the field name for *Humidity*, and the units change accordingly. NOTE: There are no default values for measurement conversions, only for the measure HSDA actually uses (which in this case is relative humidity).

a. *Humidity (Rel)* is the ratio of the water vapor present in air to the water vapor present in saturated air at the same temperature and pressure. The default setting is 10%, and the valid range is 0 to 100%.

b. *Wet Bulb Temp* is the lowest temperature that can be obtained on a wet-bulb thermometer in any given sample of air by evaporation. This is used to compute dew point and relative humidity. The valid range is 12 to 35°C.

c. *Dew Point Temp* is the temperature at which water vapor in the air first starts to condense. The dew-point temperature is a measure of the actual water-vapor content in the atmosphere. The water-vapor content is constant for any dew-point temperature regardless of the dry-bulb or wet-bulb temperature. The valid range is -273.15°C to 37.77°C.

Table 1. Overview of input variable attributes.

PARAMETER	FIELD TYPE	CONVERSION		USER-DEFINED	DEFAULT VALUE	VALID RANGE
		MEASURE	UNIT			
Temperature	Scalar	N/A	°C, °F	N/A	35°C	10.0-65.0°C
Humidity	Scalar	Rel Humidity	N/A	N/A	10%	0-100%
		Wet Bulb Temp	°C, °F	N/A	N/A	12-35°C
		Dew Pt Temp	°C, °F	N/A	N/A	-273.15-37.77°C
		Absolute Hum	N/A	N/A	N/A	0-42.18 mm Hg
Wind Speed	Scalar	N/A	m/sec, km/hr, mph, knots/sec	N/A	0.5 m/sec	0.3-20.0 m/sec
Solar Load	User-Defined	N/A	N/A	Solar Factor	0 (ND)	0-300 (ND)
				Cloud Factor	4 (ND)	0-5 (ND)
	Pick List (4)	N/A	N/A	N/A	N/A	N/A
Dehydration	User-Defined	N/A	N/A	% Dehydration	1.24%	0-20%
	Pick List (6)	N/A	N/A	N/A	N/A	N/A
Work Activity	User-Defined	N/A	watts, BTUs, kilocals/hr, METs	Work Met Rate	350 watts	75-800 watts
				External Work	0 watts	0-800 watts
	Pick List (32)	N/A	N/A	N/A	N/A	N/A
Acclimatization	Scalar	N/A	N/A	N/A	99 days	0-99 days
Soldier Attributes	User-Defined	N/A	cm, in	Height	172 cm	120-215 cm
			kg, lbs	Weight	70 kg	30-145 kg
Clothing Type	User-Defined	N/A	N/A	Clothing Insul	2.09 clo	0.4-3.0 clo
				Im/Clo Perm	0.16	0.09-2.0
				Gamma for Clo	-0.15	-0.5 - -0.1
				Gamma Im/Clo	0.20	0.1-0.6
	Pick List (31)	N/A	N/A	N/A	N/A	N/A
Accepted Casualty Risk	User-Defined	N/A	°C, °F	Single-Expos Max Temp Lim	39.0°C	0-500°C
				Max Cyclic Temp Limit	38.5°C	0-500°C
				Max Sustained Temp Limit	38.5°C	o-500°C
				Skin Temp	36.5°C	0-500°C
	Pick List (4)	N/A	N/A	N/A	N/A	N/A

d. *Humidity (Abs)* is the mass of water vapor present in a unit volume of the atmosphere, usually measured in grams per cubic meter. Absolute humidity may also be expressed in terms of the actual pressure of the water vapor present. The valid range is 0.00mm Hg to 42.18mm Hg.

Once you have decided which measurement you want to use, pressing <F2> brings up a pick list with the following choices: "Convert Humidity Measurement" and "Convert Humidity Unit". Selecting the first option brings up the menu with *Humidity (Rel)*, *Wet Bulb Temp*, *Dew Point Temp*, and *Humidity (Abs)*. Selecting the second option brings up an appropriate conversion chart for units of measure.

3.3.3 Wind Speed. The default setting for *Wind Speed* is 0.5 meters/second. The valid range is 0.3 m/sec to 20.0 m/sec. Pressing <F2> brings up the unit-conversion pick list. Units available are km/hour, miles/hour, and knots. *Wind Speed* is a scalar variable.

3.3.4 Solar Load. *Solar Load* contains predefined values which are available through a pick list. The four options are *User Defined*, *Indoors*, *Full Sun*, and *Cloudy Sky*. If you choose *User Defined*, you must enter scalar solar and cloud factors. *Solar Factor* is the intensity of the solar radiation on skin and/or clothing. The default setting is 0.0, and the valid range is 0.0 to 300.0. *Cloud Factor* is and empirical factor that combines with the *Solar Factor* to generate radiative solar transfer to the individual. The default setting is 4.0, and the valid range is 0.0 to 5.0. NOTE: *Solar Load* and its two components are non-dimensional (ND), so there are no units of measure.

3.3.5 Dehydration. *Dehydration* contains predefined values which are available through a pick list. The four levels of hydration are *User Defined*, *Fully Hydrated*, *Normally Hydrated*, and *Severely Dehydrated*. Choosing *User Defined* requires you to enter a specific level of dehydration. The default setting is 1.24%. The valid range is 0% to 20%

3.3.6 Work Activity. *Work Activity* contains 32 predefined values which are available through a scrollable pick list. The window that first appears shows only a portion of the values available. Continue to press <↓> when the cursor reaches the bottom of the window. When the list stops scrolling, you have reached the last variable. Quantitatively, work activity is expressed in watts.

User Defined for this parameter requires two numeric values: *Work Metabolic Rate* (watts) and *External Work* (watts). *Work Metabolic Rate* is the energy demand to continue the activity in which an individual is currently engaged. The default setting is 350.0 watts, and the valid range is 75.0 to 800.0 watts. *External Work* is the amount of physical work an individual is capable of conducting for the given metabolic rate at which he is currently working. The default is 0.0 watts, and the valid range is 0.0 to 800.0 watts.

3.3.7 Acclimatization. *Acclimatization* is a measure of the length of time (days) required for an individual to adapt to the new environment (described by the other parameters). *Acclimatization* is a scalar variable. The default is 99 days, and the valid range is 0 to 99 days.

3.3.8 Soldier Attributes. *Soldier Attributes* refers to the physical size of the individual. Selecting *Soldier Attributes* brings up a window where you can enter individual height (cm) and weight (kg) values. The default value for height is 172cm, with a valid range of 120-215cm; the default value for weight is 70kg, with a valid range of 30-145kg. Centimeters-to-inches and kilograms-to-pounds conversion options are available by pressing **<F2>**.

3.3.9 Clothing Type. *Clothing Type* contains an extensive pick list of clothing choices. This list is scrollable. When the cursor reaches the bottom of the list, continue to press **<↓>** to see more values until the list stops scrolling. Use the **<↑>** key to move back up the list if necessary. The first option is *User Defined*, which requires you to input four scalar values: *Clothing Insulation* (Clo), *Im/Clo Permeability*, *Gamma for Clo*, and *Gamma for Im/Clo*. Clo is a measurement of the relative thermal-insulation properties of different types of fabrics and clothing. The default value for *Clothing Insulation* is 2.09 clo, and the valid range is 0.4 Clo to 3.0 Clo. *Im/Clo Permeability* refers to the moisture permeability of clothing. The default value is 0.16, and the valid range is 0.09 to 2.0. Gamma is an exponential coefficient that changes Clo and Im/Clo values as a function of wind speed. The default value for *Gamma for Clo* is -0.15, and the valid range is -0.5 to -0.1; the default value for *Gamma for Im/Clo* is 0.20, and the valid range is 0.1 to 0.6.

3.3.10 Accepted Casualty Risk. *Accepted Casualty Risk* contains a pick list with four values: *User Defined*, *Light* (5%), *Moderate* (20%), and *Heavy* (50%). Selecting *User Defined* requires you to enter values for the following four variables:

a. *Single Exposure Maximum Temperature Limit* is the highest core temperature that an individual can reach until maximum exertion occurs. The default value is 39.0°C, and the valid range is 0.0°C to 500.0°C.

b. *Maximum Cyclic Temperature Limit*, combined with work/recovery values, refers to how high an individual's core temperature can reach before the individual must stop and rest. The default value is 38.5°C, and the valid range is 0.0°C to 500.0°C.

c. *Maximum Sustained Temperature Limit* is the core temperature of an individual working indefinitely at a specific temperature. The default value is 38.5°C, and the valid range is 0.0°C to 500.0°C.

d. *Skin Temperature*. The default value is 36.5°C, and the valid range is 0.0°C to 500.0°C.

NOTE: Valid range is always defined from HSDA's perspective, i.e., minimum and maximum values that it can accommodate in its calculations. If values you want to enter fall outside this range or -- as above -- never approach the limits, it does not necessarily mean they are unreasonable.

3.4 Types of Output

HSDA outputs vary in form, function, and the issues they address. While HSDA imposes certain constraints due to practical considerations (e.g., multiple-input sets can be graphed but not displayed simply because there is not enough space on the main screen), it also tailors outputs to the needs of the variety of users who might be using the application for substantially different purposes. Three types of HSDA outputs, identified by the type of input sets initially used, are described in the following paragraphs and summarized in Table 2. The ways in which HSDA results can be used, however, are not limited to HSDA display and graph options. All results can be saved (see Section 3.8) and exported to other applications, where you can manipulate them in a variety of ways. Section 3.9 describes how HSDA graphics can be captured from the computer screen and printed.

3.5 Single-Input Displays and Graphs

If you only entered one value for each input variable, you can view the results as a numeric display or as a line graph.

3.5.1 Numeric Display. Displayed output tells you what -- given your specified input (including accepted casualty risk) -- thermal discipline you should follow and the consequences of not adhering to any discipline. Because only one value was used for each variable, this display represents a "snapshot" of a single set of conditions requiring little interpretation. As such, it could be useful in ongoing military operations where, for example, adverse conditions require careful monitoring and periodic adjustment of workload, crew rest schedules, or even timing of a mission (e.g., delaying attack until the heat of the day passes).

You can generate this type of output by selecting the **Calculate** option from the menu bar. The result will be displayed in the bottom five lines the main screen (see Figure 5) in the following two columns:

a. **Recommended Discipline.** Two values under Recommended Discipline, *Work Cycle* (min) and *Water Required* (cn/hr), appear as work/rest ratios. The third value, *Maximum Work Time* (min) is a single value representing the longest allowable period of continuous work.

Table 2. Overview of output attributes.

INPUTS	OUTPUTS		
	DISCIPLINE	**PARAMETERS**	**FORM**
SINGLE	Recommended Discipline	Work Cycle (W:R)	Numeric Display ASCII File
		Water Required (W:R)	
		Maximum Work Time	
	Without Discipline	Equilibrium Temperature	
		Probability of Casualty	
	No Thermal Discipline	Core Temperature vs Time	Line Graph ASCII File
	Work/Rest Discipline		
	Custom Discipline (Specify Work, Rest Times)		
	Any Combination of the Above		
DUAL	Any Combination of the Above	Core Temperature vs Time	Line Graph ASCII File
MULTIPLE (3-8)	Recommended Discipline	Work Time	Bar Chart ASCII File
		Recovery Time	
		Work Water Requirements	
		Recovery Water Requirements	
		Maximum Work Time	
	Without Discipline	Work Equilibrium Temperature	
		Rest Equilibrium Temperature	
		Probability of Casualty	

b. **Without Discipline.** *Equilibrium [Core] Temperature* (°C) is shown together with *Probability of Casualty.*

3.5.2 Line Graphs. If you want to see the effects of the input variables you have selected in graphic form, HSDA will show you what happens to core temperature over time, i.e., it will generate a temperature time series. To view this, select the **Graph** command on the menu bar. If you have not already selected **Calculate**, the **Graph** command runs the calculations for your input values before continuing into the **Graph** pull-down menu. As shown in Figure 6, this menu offers four choices:

a. **No Thermal Discipline.** Selecting *No Thermal Discipline* graphs the results for conditions where no work/rest cycles or other forms of thermal discipline were applied. In other words, the graph shows the combined effects of the conditions you have specified in HSDA **Input** menus on the core temperature of an extended effort where no discipline for preventing heat strain casualties was used.

b. **Work/Rest Discipline.** In contrast, *Work/Rest Discipline* shows you what would happen under the same conditions if the work/rest regimens predicted by HSDA were applied. Graphing both *No Thermal Discipline* and *Work/Rest Discipline* highlights the difference.

c. **Custom Thermal Discipline.** Selecting *Custom Thermal Discipline* brings up another window with scalar fields for *Work Time* (min) and *Rest Time* (min). You may enter your own values. The screen also displays the work/rest times predicted by HDSA for reference.

Select one or more of the above options by moving your cursor to the desired option and pressing **<Enter>**, as shown in Figure 6. A ">" appears beside the selection. When you are ready to see the graph, choose *Run Selections*, and HSDA draws the graph. An example is shown in Figure 7. You will notice that your original inputs are displayed in the left portion of the graphics screen. In addition, pressing **<F4>** brings up a window that shows the values and types of discipline each curve represents. This type of output requires more interpretation than the simple display described above. However, because it compares various conditions and allows the viewer to see the kind of functions that are generated, it should be of interest to researchers and materiel testers.

3.6 Dual-Input Line Graphs

If you have entered two values for any of the input variables, you cannot generate a numeric display by selecting the **Calculate** option on the menu bar as you could if you had only used one value/variable. You can, however, generate core temperature time series graphs with all the discipline options described above while

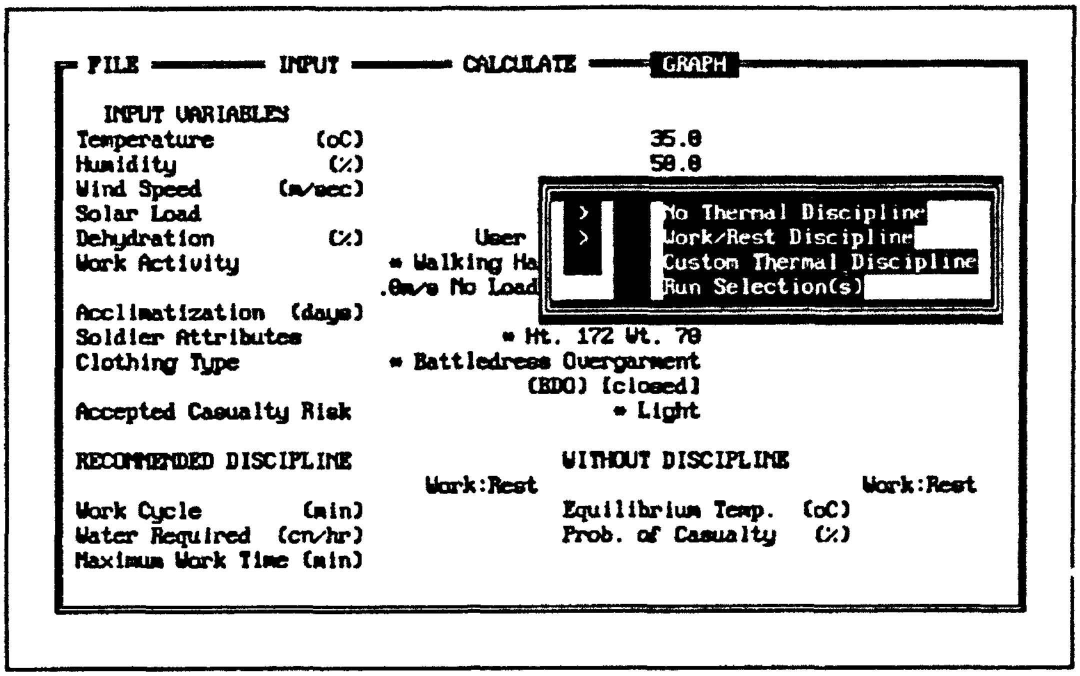

Figure 6. Selecting thermal disciplines for a line-graph (core temperature time series) display.

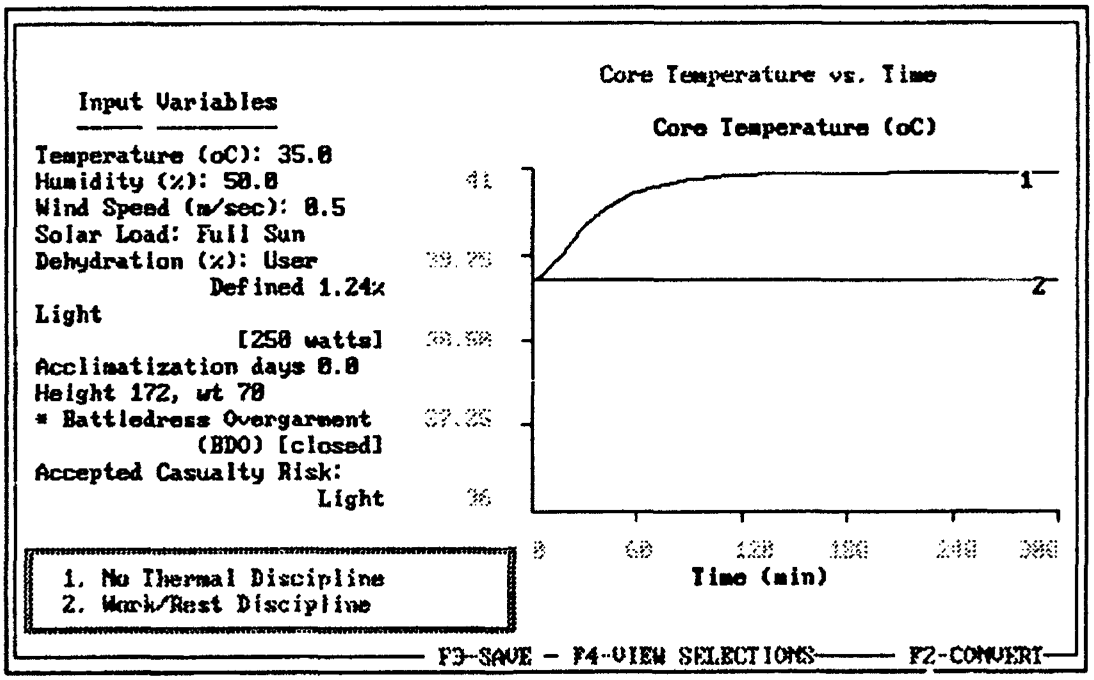

Figure 7. Single-input (core temperature time series) line graph.

being able to look at the effects of two input variables simultaneously. In addition, you have the option of viewing other types of graphics described in the following section.

3.7 Multiple-Input Bar Charts

Multiple inputs can be graphed but not displayed. This extends to the input variables listed at the left side of the graph: the graphed variable is omitted. In addition, graphs based on multiple inputs cannot show the effects of different thermal disciplines. Finally, the core temperature time series is not available for more than two inputs. In fact, no line graphs are available. However, the bar charts you can generate give you the advantage of taking a detailed look at how each of the input variables -- at different values -- affects basic components of soldier performance and endurance: *Work Time* and *Recovery Time*, *Work Water Requirements* and *Rest Water Requirements*, and *Maximum Work Time* under the recommended discipline and *Work Equilibrium [Core] Temperature* and *Probability of Casualty* when no discipline is effected.

To generate a bar chart, select the **Graph** command and a menu showing these options (see Figure 8) will appear. Note that the one input variable for which you have provided multiple inputs also automatically appears as part of each menu selection, e.g., multiple entries for *Work Activity* in **Input** result in selections that read "... *vs Work Activity*". If you then return to **Input**, eliminate all but one value for Work Activity and enter multiple values for *Accepted Casualty Risk*, the menu selections would read "... *vs Accepted Casualty Risk*". Such systematic evaluation of environmental and soldier-related variables could be useful, for example, for military planners and analysts.

3.8 Saving Output to a File

You have two opportunities to save your inputs and results to a readable text file (ASCII): immediately after selecting **Calculate** from the menu bar and while a graph is displayed on the screen. In both instances, press the **<F3>** key to initiate the save. HSDA asks you for a file name, as shown in Figure 10. NOTE: DOS file naming conventions must be followed:

a. You cannot use more than eight characters. An optional three-character extension preceded by a period can be added (for example, .txt) so that you know it is an ASCII file that HSDA cannot use.

b. You cannot use unacceptable characters such as:

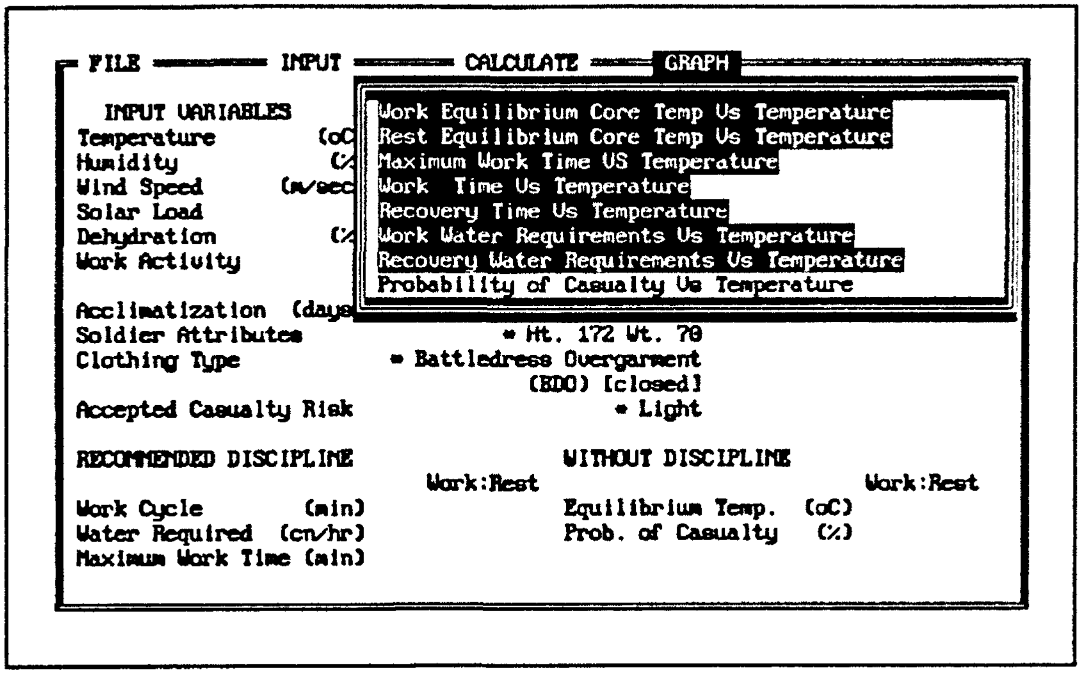

Figure 8. Selecting functions for a multiple-input graph.

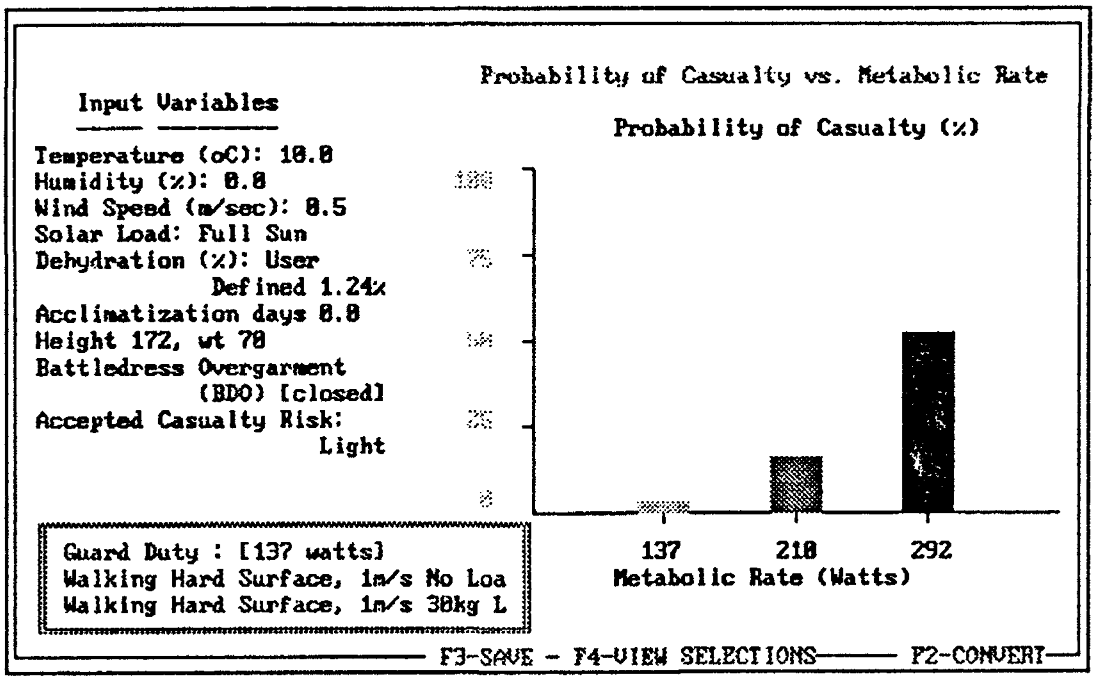

Figure 9. A Multiple-input bar graph function.

- o Spaces
- o Periods (except to separate a name and its extension)
- o Commas
- o Pipe characters (|), forward slashes, backslashes
- o Semicolons or colons
- o Square or angle brackets
- o Asterisks or question marks

c. Hyphens and underscores can be used to make filenames more readable.

The difference between saving after **Calculate** and saving during **Graph** is that **Graph** puts the data in format according to what it being graphed, as shown in Figure 11. You may then print the files through DOS, or you may want to edit them in a word processor so the can be exported to for analysis or entry in graphics data tables.

3.9 Capturing and Printing a Graph

If you want a copy of the graph you have generated on the computer screen, you can use any of a number of commercial screen capture utilities. If you don't know whether you have one installed on your computer, check your graphics package. Most come with capture utilities. The advantage of using screen capture is that it is easy to use and the file generated can be exported to a range of other applications. For example, you can import a screen capture file unchanged into a word processing application. The figures showing HSDA screens in this manual were generated using screen capture. Exporting screen capture files to graphics packages allows you to add enhancements or -- depending on the capabilities of the specific application you use -- enhance the image itself. Since procedures vary depending on the kind of capture utility you have and the application to which you choose to the capture file, we suggest you consult the appropriate manuals. If you were using Harvard Graphics[1], for example, you would follow these general steps:

a. Load screen capture. Move to the directory where the capture program is installed, e.g., the root directory, and type "**capture**" after the prompt. You will see a message indicating that the utility has been loaded.

b. Generate an HSDA graph and take a "snapshot". Display the screen you want captured and press **<Shift-PrintScreen>**.

```
FILE ======== INPUT ======== CALCULATE ==== GRAPH ================
                                  Save current data in a
 INPUT VARIABLES                  text file? [Y/N] [ y ]
Temperature          (oC)
H
W  Enter name for text file
S  [ c:\projects\heat\activity.txt                              ]
D
Work Activity                    Multiple Selections
Acclimatization  (days)                          0.0
Soldier Attributes                  * Ht. 172 Wt. 70
Clothing Type                 * Battledress Overgarment
                                        (BDO) [closed]
Accepted Casualty Risk                         * Light

RECOMMENDED DISCIPLINE                WITHOUT DISCIPLINE
                          Work:Rest                          Work:Rest
Work Cycle          (min)             Equilibrium Temp.  (oC)
Water Required   (cm/hr)              Prob. of Casualty   (%)
Maximum Work Time (min)
```

Figure 10. Saving input data as a text file.

```
Ambient Temperature: 35.00
Humidity:  50.00
Wind Speed:  0.50
Solar Factor: 150.00
Cloud Factor: 2.50
Height: 172.00
Weight:  70.00
Work Metabolic Rate: 525.00
External Work:   0.00
Acclimatization:  0.00
Dehydration:  1.24
Skin Temperature: 36.50
Clo: 2.09
Im/Clo: 0.16
GammaC: -0.15
GammaI: 0.20
Max_Work_Temp_Limit: 39.00
Max_Cyclic_Temp_Limit: 38.50
Max_Met_Limit_Temp_Limit: 38.50
TREF_WORK: 45.77
DTREF_WORK:  1.034
Final_Temperature: 46.804
TREF_RECOVERY: 38.650
DTREF_RECOVERY:  0.728
C:\HJZ\ACTIVITY.TXT                                 Doc 1 Pg 1 Ln 1" Pos 1"
```

Figure 11. An example of an HSDA graph saved in a text file.

c. Change the colors. If you have a color printer, you may want to adjust the HSDA colors to give you a better image. This may also help with monochrome. You can do this using the **Palette** option on the screen capture menu that appears.

d. Save to a file. Using the menu options provided, specify the output format, the directory and subdirectories where you want the file to reside. Screen capture automatically assigns a file name, e.g., SCREEN02.PCX for the second screen capture file you create. Write down the file name along with a description; you will need this when you import the file to another application.

e. Import to Harvard Graphics1. Select **Draw** from the Main Menu and, using the tree icon, bring up the file. Modify using instructions in the Harvard Graphics[1] manual or save and print, using **File** and **Output** main menu options

---

[1] Harvard Graphics is a registered trademark of Software Publishing Corporation.

[2] IBM is a registered trademark of International Business Machines Corporation.

[3] Sidekick is a registered trademark of Borland International, Inc.

BIBLIOGRAPHY

The objective of this manual is to help you use the HSDA to generate useful outputs. While some background information is provided and terms are defined, we assume the user has a general understanding of issues related to heat strain. If you feel you might benefit from some additional reading, we suggest:

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Passmore, R., & Durnin, J.V.G.A. Human energy expenditure. **Physiol. Rev.**: 35, 1955.

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Stark, M.M., McNally, R.E., Sanzone, M.A., Powers, J.P., & Bowen, M.P. Analysis of DED field results: Determination of key factors which place soldiers at risk for thermal stress (Technical Report, Contract No. DAMD17-

88-C-8155). Joppa, MD: Science Applications International Corporation, 1992.

APPENDIX

APPENDIX A: GLOSSARY

absolute humidity	The mass of water vapor present in a unit volume of the atmosphere. Absolute humidity may also be expressed in terms of the actual pressure of the water vapor present.
acclimatization	The adaptive changes that occur within an organism in response to changes in the natural climate.
Ada	A programming language developed in the late 1970s to overcome shortcomings of existing languages used for Department of Defense (DOD) software development and established as a standard (ANSI/MIL-STD-1815A) in 1983. Named after Adda Lovelace, a nineteenth century mathematician considered to be the first programmer.
ambient temperature	The temperature of the surrounding air. (See dry-bulb temperature.)
application	A computer program used for a particular type of work, e.g., heat strain prediction. This term is used interchangeably with "program".
arrow keys	Keys on the numeric keypad (usually on the right side of the keyboard) used to move the cursor or cell selector.
ASCII	American Standard Code for Exchange. A standard that assigns a specific code to each of 128 digits, letters, and control characters. The ASCII character set is the most universal character-coding set.
autoexec.bat	The batch file DOS uses when it starts the computer.
bar chart	An XY chart in which data points are displayed as bars.

binary file	A file containing information that is in machine-readable form. It can only be read by an application, e.g., HSDA.
BTU	British thermal unit. The quantity of heat required to raise the temperature of one pound of water from 60° to 61°F at a constant pressure of one atmosphere. As used here, it is one of several units of measure for heat generated through work activity.
clo	A unit of measurement used to express the relative thermal insulation values of different types of clothing ensembles. One clo represents the insulation provided by typical indoor clothing worn by a sedentary individual working in a comfortable indoor environment.
cloud factor	An empirical factor which, when combined with the solar factor, represents radiant solar transfer to the individual.
code	A system of symbols and rules used to represent instructions to computers.
core temperature	The internal body temperature of individuals, best measured by an invasive device rather than an oral thermometer.
config.sys	A text file that contains configuration commands used when you start your computer. Commands enable or disable system features, set limits on resources, and extend operating-system functionality by loading device drivers.
default	A standard setting automatically used if no other is specified.
dehydration	Excessive loss of water from the body, as from inadequate fluid intake.
dew point temperature	The temperature at which condensation first occur when an air-water vapor mixture is cooled at a constant pressure.

directory	Part of a structure for organizing your files on disk. A directory can contain files and other directories (subdirectories). The structure of directories and subdirectories on a disk can be viewed by calling up the directory tree.
discipline	Training expected to produce a specific pattern of behavior, such as water or work-rest discipline for soldiers.
disk	A medium for storing information. Information stored on a disk remains there even when you turn your computer off, unlike information stored in memory (RAM). A floppy disk can be inserted and removed from a floppy disk drive, whereas a hard disk is permanently mounted inside its drive.
DOS	Disk Operating System, the computer system required to run HSDA.
drive	A device for storing and retrieving information on disks.
error message	A message telling you that the application or the system has not understood you.
equilibrium	A condition in which all acting influences are cancelled by others, resulting in a stable, balanced, or unchanging system.
exporting	Saving an output in a different format so you can use it in a different application.
external work	The amount of physical work an individual is capable of conducting for the metabolic rate at which he is currently working.
field	A category of information in a database.
file	A collection of information that has been given a name and is stored on disk. This information can be a document or an application.

function key	Keys labeled <F1> through <F10> or <F12> at the left or top of the keyboard used to perform special functions. HSDA uses <F2>, <F3>, and <F4>.
heat strain	Thermal effects on the operational characteristics and capabilities of soldiers and units.
gamma	Here, an exponential coefficient than changes Clo and Im/Clo values as a function of wind speed.
im/clo permeability	A measure of the moisture permeability of clothing.
kilobyte (K)	A unit of measurement of the memory capacity of a computer, equal to 1,024 (2^{10}) bytes.
kilocalorie	The unit of heat equal to the amount of heat required to raise the temperature of one gram of water from 0° to 100°C at one atmosphere of pressure. Here, used as one of a number of units of measure for the heat generated by work activity.
math coprocessor	An addition the a computer's central processing unit (CPU) that relieves the burden of performing certain mathematical operations, improving operating speed; used for intense "number-crunching" tasks such as spreadsheets, program compiling, and mathematical modeling.
maximum cyclic temperature limit	Combined with work-recovery values, indicates how high an individual's core temperature can reach before the individual must stop and rest.
maximum sustained temperature	The highest core temperature at which an limit individual can work indefinitely under a given ambient temperature.
megabyte (M)	1024 kilobytes (1,048,576 bytes) of information or storage space.
memory-resident	A program that is loaded into memory and is available even when another application is active.

menu bar	The area at the top of the screen where you make selections to display pull-down menus or perform other actions.
metabolism	The complex of physical and chemical processes occurring within a living cell or organism that are necessary for maintaining life. In metabolism, some substances are broken down to yield energy for vital processes while other substances necessary for life are synthesized.
MET	An empirical unit of measure for the resting metabolic rate of a person whose clothing insulation properties equal one clo.
ND	Non-dimensional, i.e., something that cannot be directly measured.
parameter	One of a set of measurable factors such as temperature or humidity that define a system, determine its behavior, and can be varied experimentally.
root directory	The main directory of a disk. Every formatted DOS disk, whether hard or floppy, has this level of directory from all other directory levels stem.
pick list	A type of box or window that lists available choices. If all the choices do not fit, scrolling is available.
pop-up menu	Boxes (windows) of options that appear after you chose a menu option.
pull-down menu	A list of commands or operations that either drops down when select it from the menu bar or can by pulled down using a mouse.
RAM	Random Access Memory. A temporary storage area within your computer, used for storing your work until you save it to disk.
relative humidity	The ratio of water vapor in the air at a specific temperature to the maximum amount that the air

	could hold at that temperature, expressed as a percentage.
screen capture	A computer utility that allows you to save any ASCII characters a monitor screen contains and reproduce them in another application. The main portion of the screen, menus, prompts, and borders can all be captured.
scroll	To move through text or graphics (up, down, left, right) in order to see parts of the file or list than cannot fit on the screen.
scalar	Having only magnitude. Used of numbers or quantities.
single-exposure maximum temperature limit	The core temperature limit to which someone can work with maximum exertion.
solar load	Radiant heat exchange is the net rate of heat exchange by radiation between an organism and its environment, usually expressed in terms of unit area of the total body surface. Solar load (and radiant load) refers to heat gain.
solar factor	The intensity of solar radiation on skin or clothing.
USARIEM	US Army Research Institute of Environmental Medicine, one of the nine Army medical research laboratories and institutes of the US Army Medical Research and Development Command (USAMRDC), which is a field-operating agency of the Office of The Surgeon General of the US Army. USARIEM conducts basic and applied research to determine the effects of heat, cold, high terrestrial altitude, nutrition, work, and chemical defense protective measures on the soldier's health and performance.
user interface	The point of interaction or communication between a computer and a human operator.
VGA	Video graphics array, used to describe computer monitors.

watt	A unit of energy used to describe how hard an individual is working, with 1,000 watts accrued over time expressed as kilowatt hours.
wet bulb temperature	The lowest temperature a sample of air can be cooled by evaporating water.
work metabolic rate	The energy demand made by continuing an activity in which an individual is currently engaged.
X axis	The horizontal scale at the bottom of a graph.
Y axis	The vertical scale at the left of a graph.

APPENDIX B: ERROR MESSAGES AND PROBLEMS

MESSAGE	PROBLEM	SOLUTION
N/A	Screen is blank after HSDA is installed	HSDA needs all of the following files installed in the HSDA directory to run: HSDA.EXE (executable) COURB12.FNT (fonts) DEFAULT.SET (input default settings) If you have not installed or accidentally deleted the font file, do so now.
EXCEPTION NEVER HANDLED: STORAGE ERROR	If you have memory-resident programs occupying more space than HSDA leaves available, HSDA will not run.	Download memory-resident programs as necessary. Most memory-resident programs are initiated from AUTOEXEC.BAT or CONFIG.SYS
SELECTED FILE IS NOT A VALID FILE	Not all files you have in your HSDA directory can be used by HSDA to retrieve input values: only binary files will work.	Try again. Also, the next time you save HSDA inputs, use the file name extension to identify HSDA input files in a consistent, unmistakable manner.
A [input variable] VALUE OF [value you just entered] IS OUT OF RANGE. VALUE MUST BE GREATER THAN OR EQUAL TO [lower limit of valid range] AND LESS THAN OR EQUAL TO [upper limit of valid range].	You have entered an input value that HSDA cannot accommodate. NOTE: This message does not necessarily mean you have entered an unreasonable value.	Reenter a within-range value. Also, you might want to keep this manual open to Table 1 while entering data: default values and valid ranges for all input parameters are presented on a single page.
THIS VERSION OF THE HEAT STRAIN PREDICTION MODEL ONLY ALLOWS THE USER TO VARY ONE INPUT PARAMETER AT A TIME.	You have multiple input for another variable. NOTE: HSDA carries forward input data from the previous session.	Replace the data of the parameter you do not currently want to vary with a single value. Also, it is a good idea to check the values for all parameters before starting a session. This way, you will avoid unintentionally using a carried-over value you do not way to use.
EXCEPTION NEVER HANDLED: LAYOUT ERROR	You have inadvertently exceeded the capabilities of the field, and the program could not recover.	Type in HSDA at the prompt, try again using different values.

APPENDIX C: HSDA USER SURVEY

We would appreciate any input you have on either the HSDA User's Manual or the HSDA application itself. The following form consists of a series of statements. Check the column that best represents how much you agree with the statement. Some space has been provided for comments relevant to each statement. Feel free to use additional pages or address issues not mentioned here. Please mail your responses to the address provided in Section 1.5 (Assistance and Problem Reporting) of this manual. It would be helpful of you could include your name, address, and phone number in case we have some follow-on questions.

STATEMENT	AGREE		
	Strongly	Some-what	Not At All
1. The HSDA has real military relevance.			
Comments:			
2. I can see how I could use the HSDA in the kind of work I do.			
Comments:			
3. I don't have enough experience with computer models to understand the HSDA.			
Comments:			
4. I don't know enough about heat strain to understand the HSDA.			
Comments:			
5. The User's Manual was -- overall -- understandable and helpful.			
Comments:			
6. I did not understand the installation and operating instructions in the manual.			
Comments:			
7. The heat-strain terminology was difficult to understand.			
Comments:			

STATEMENT	AGREE		
	Strongly	Somew-hat	Not At All
8. Reading the documents cited in the bibliography gave me a better understanding of heat strain issues.			
Comments:			
9. I really did not need the manual; the HSDA is easy to use and understand.			
Comments:			
10. I had trouble installing and running the HSDA with the equipment I have.			
Comments:			
11. I had no problems entering data.			
Comments:			
12. The input pick lists did not contain the items I needed.			
Comments:			
13. I found the numeric output displayed at the bottom of the screen useful.			
Comments:			
14. I found the core temperature line graphs useful.			
Comments:			

STATEMENT	AGREE		
	Strongly	Somewhat	Not At All
15. I found the multiple-input bar charts useful.			
Comments:			
16. I had trouble deciding what menu selections to use to get the displays I wanted.			
Comments:			
17. I had trouble saving and retrieving files.			
Comments:			
18. I was able to get good-quality graphics using a screen-capture utility.			
Comments:			
19. Exporting text files to other applications or using them in other applications was troublesome.			
Comments:			
20. I found serious errors in the manual or "bugs" in the software.			
If you did, we would appreciate it if you would use additional pages to provide a detailed response. For manual errors, please describe the problem and cite the paragraph number. For software "bugs", please give the command used, the function performed, and a description of what happened.			